AN NOVEL APPROACH FOR THE REMOVAL OF IMPULSE NOISE USING MEDIAN FILTER

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ABSTRACT

In this paper we have proposed a new decision based algorithm for the removal of salt and pepper noise, also known as bipolar impulse noise. Here, comparison of matrices such as 3 x 3, 5 x 5, 7 x 7, 9 x 9, 11x11 is performed using median filtering techniques. From the result obtained, it is found that 5 x 5 is better to produce the clear noise free image with high degree of salt and pepper noise elimination compared to previously proposed method. This is done with the help of MATLAB coding by considering the matrix window pixel for the corrupted image.

KEYWORDS: Matrix Window Pixel, Noise- Free Image is Fully Recovered, Adjacent Pixel Value of the Corrupted Image

INTRODUCTION

Digital image processing finds its application in many important fields such as satellite communication, business applications etc. Processing an image is a complex task. Any signal processing system, even though it is digital, it is not perfect due to the constraints of noise. Therefore, main problem in image processing is to reduce the effect of noise and present it with perceptible details.

During the transmissions of images over channels, images are often corrupted by impulse noise due to faulty communication or noisy channels. Such noises may be introduced due to faulty camera or the like. In a black and white digitized image, pixels corrupted by positive impulses appear as white dots and those corrupted by negative impulses appear as black dots. The objective is to remove impulses so that the noise- free image is fully recovered with a minimum signal distortion. To reduce the effect of noise, restoration techniques are available; filtering is one among those techniques. Filters are of two types linear filters and non-linear filters.

Median filter is a non-linear filter which eliminates the salt and pepper noise from the corrupted image. Here we have used standard median filter which effectively removes the noise from the corrupted image. The 3 x 3 window for an image is not that much efficient because when you consider the whole image and perform sorting for the corrupted pixel by using median filtering technique it results in blurred image. 3 x 3 windowing technique remove the noise effectively even at noise level as high as 90% and preserve the edges without any loss upto 80% of noise level.

EXISTING METHODS

In 3 x 3 windowing technique, a particular set of pixels of corrupted image is taken and based on the median value sorting is performed. If the median value lies between (0,255), then sorting process is not necessary. If the median value is 255, then adjacent pixel value of the corrupted image is taken to eliminate noise. If the noise density is high, there is a possibility that the median value is also a noise value.

PROPOSED METHODS

In this method, to eliminate the corrupted pixel from the image of a 5 x 5 matrix the following sorting is performed. This is illustrated with the help of following matrix.

Corrupted Matrix

123	0	156	255	234
255	0	214	98	0
0	234	255	133	190
199	255	234	255	0
255	167	210	198	178

Row Sorting →

0	123	156	234	255
0	0	98	214	255
0	133	190	234	255
0	199	234	255	255
167	178	198	210	255

Figure 1: Corrupted Matrix (Left), Row Sorting (Right)

Column Sorting ↓

0	0	98	210	255
0	123	156	214	255
0	133	190	234	255
0	178	198	234	255
167	199	234	255	255

Diagonal Sorting

0	0	98	210	167
0	123	156	178	255
0	133	190	234	255
0	214	198	234	255
255	199	234	255	255

Figure 2: Column Sorting (Left), Diagonal Sorting (Right)

In the above 5 x 5 matrix, the centre pixel is corrupted. So, it is called as corrupted matrix. This must be replaced by the value in the range of (0,255). Then row sorting is performed. But, the P_{max} value along the adjacent diagonal is 255 which is maximum value. In order to minimize that value we are going for column sorting. After performing column sorting also we get the diagonal value as 255. So we are going for the diagonal sorting where the adjacent diagonal value is in the required range [P_{min}, (0,255), P_{max}].

Let us consider an image with a corrupted pixel. By using the PSNR value you can find out the noise level. If PSNR value increases noise level decreases and as a result the image is noise free. By using this we can prove that 5 x 5 is better than 3 x 3. This is done with the help of following formula.

$$PSNR = 10\log 10 \left(\frac{255^2}{MSE} \right)$$

$$MSE = \frac{\sum_{ij} (r_{ij} - x_{ij})^2}{MN}$$

Where

MSE   mean square error;

n   corrupted image; R original image;

M X N   size of image;

x   restored image

Different cases are considered for the 3x3 matrix of corrupted image. They are as follows.

Case 1

The P(X ,Y) is an uncorrupted pixel if Pmin< P(X,Y)< Pmax,min>0, and Pmax <255;the pixel being processed is left unchanged. Otherwise, P(X,Y) is a corrupted pixel.

Case 2

If P (X,Y) is a corrupted pixel, it is replaced by its median value if Pmin <Pmed <Pmax and

0<Pmed<255.

Case 3

If Pmin < Pmed< Pmax is not satisfied or 255< Pmed=0, then P med is a noisy pixel. In this case, the P(X,Y) is replaced by the value of neighbourhood pixel value.

Similar cases are considered for 5 x 5 but the main difference is that after performing sorting, here, you can get the pixel value between (0,255). The centre pixel value is uncorrupted by noise and this helps to reduce the effect of salt and pepper noise to large extend. Since we are considering median filtering technique we mainly consider the centre pixel value for the elimination of noise. Noisy pixel value is replaced by a noise free pixel value using this method. There are various n x n matrices are possible for an image and we are proving that 5x5 is better than all other matrix values of the corrupted pixel. Sorting also helps to eliminate the centre corrupted pixel of an image. There are various types of sorting are possible which are shown above. From [2] also we can conclude that 5x5 is better than all other matrix combinations. Clarity of the picture is the main factor which we consider in our day to day life. This clarity is achieved only with the help of elimination of noise from the corrupted part of the image. For 40% noise the comparison output for the standard median filter by considering different matrices across the corrupted images are as follows.

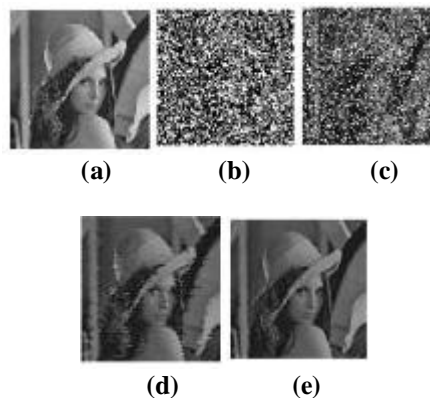(a)   (b)   (c)

(d)   (e)

Figure 3: (a) Original Image, (b) Corrupted Image, (c) Output of SMF, (d) Simulation Output for the 3 X 3 Matrix of the Corrupted Image, (e) Simulation Output for the 5 X 5 Matrix of the Corrupted Image

Table 1: Comparision of Various Windows of Corrupted Image

Selected Window	MSE	PSNR
3×3	24.6301	34.2161
5×5	24.2619	34.2816
7×7	28.0790	33.6470
9×9	32.2656	33.0434

CONCLUSIONS

Thus we can conclude that by comparing 3x3, 5x5, 7x7, 9x9 corrupted matrixes of an image using standard median filtering techniques proves that 5x5 is better than all other matrix combinations. This helps to eliminate the salt and pepper noise of corrupted pixel and provides better noise elimination capability. The amount of noise eliminated can be estimated by considering the PSNR values. The PSNR value is inversely proportional to the noise and if noise level decreases then the PSNR value increases. To analyze it better we can refer back to the Table 1. All the results were obtained by using MATLAB coding and the better noise removal of the images is shown in the above figure. Effective noise removal is seen upto 90% and bipolar noise free image is obtained.

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